Christopher Morley, *Human Being, A Story, 1932:*

"...the most astounding achievement of society has been to train millions of people to think they believe certain ideas which they often don't believe at all."

1. We ***know*** that very high levels of air pollution are acutely lethal.
2. We have been ***told*** that current levels are demonstrably lethal too.
3. We have been ***told*** that the lethal agents in the fatal episodes of air pollution are ***particulate matter*** (otherwise unspecified), and ***sulfur dioxide***.
4. We have been ***told*** that this lethality, due to particulate matter and/or sulfur dioxide, has no threshold in its dose response relationship – that there are ***no safe levels of exposure*** to particulate matter.

But do we ***believe*** what we are told?

London, daylight, early December 1952

London December 1952

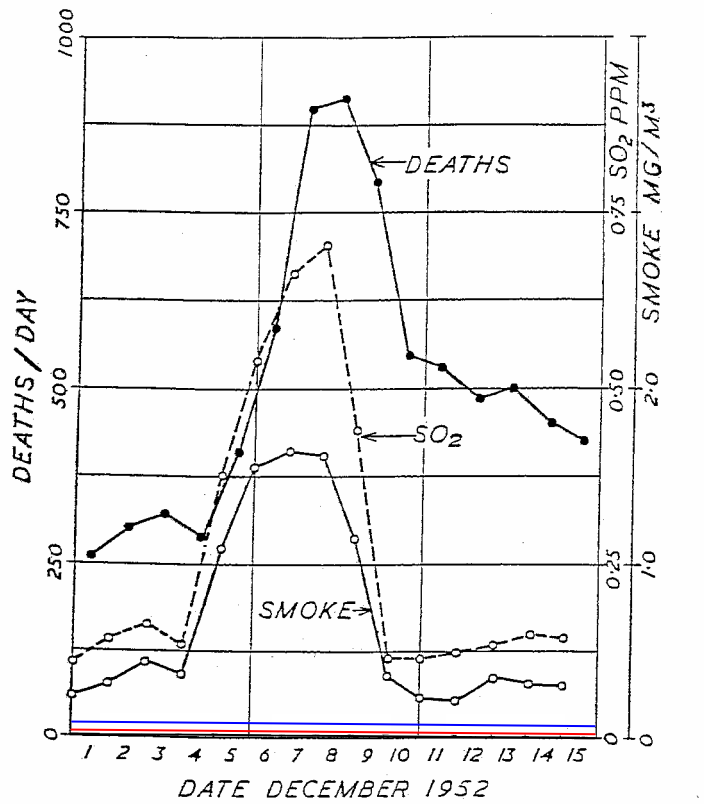
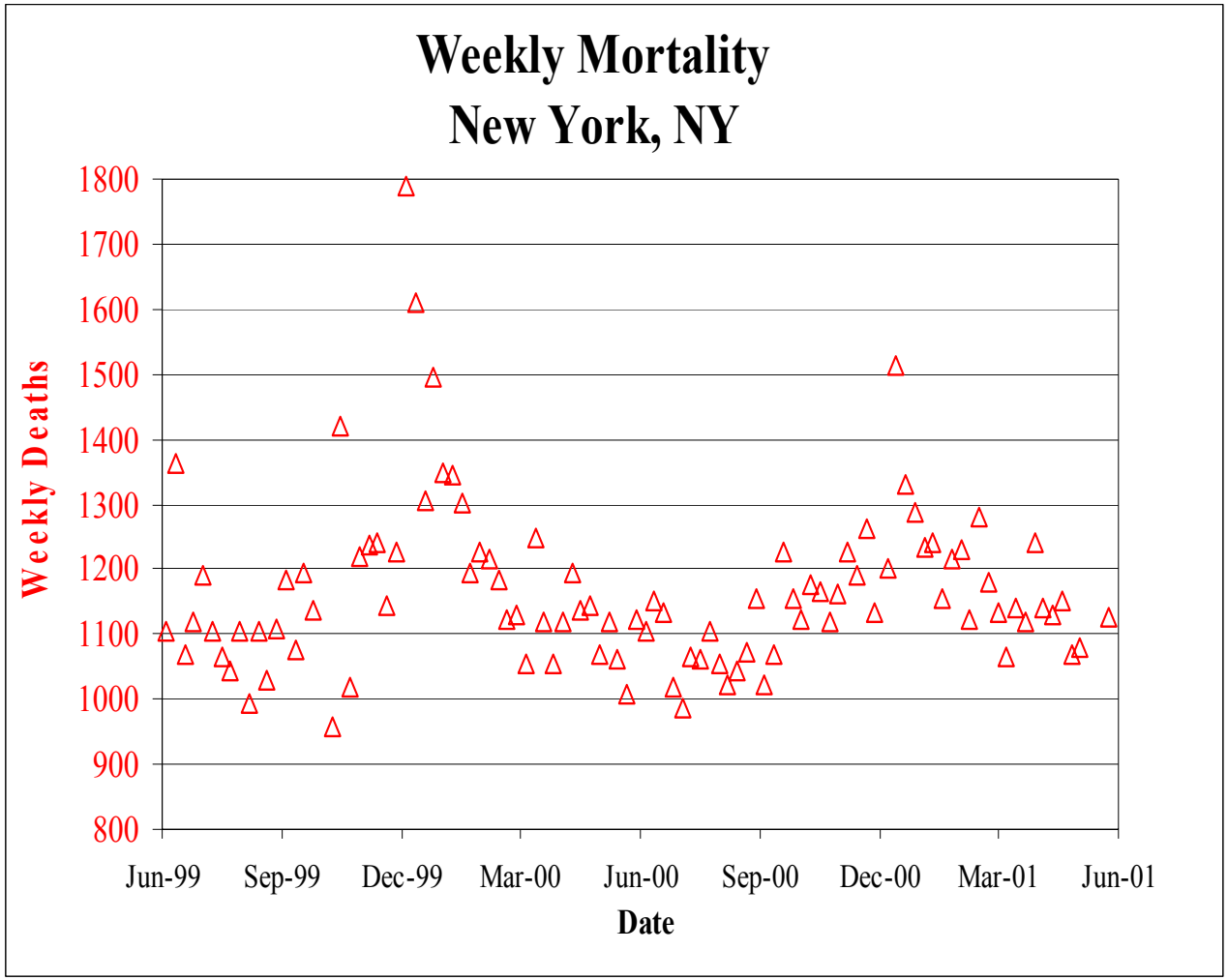


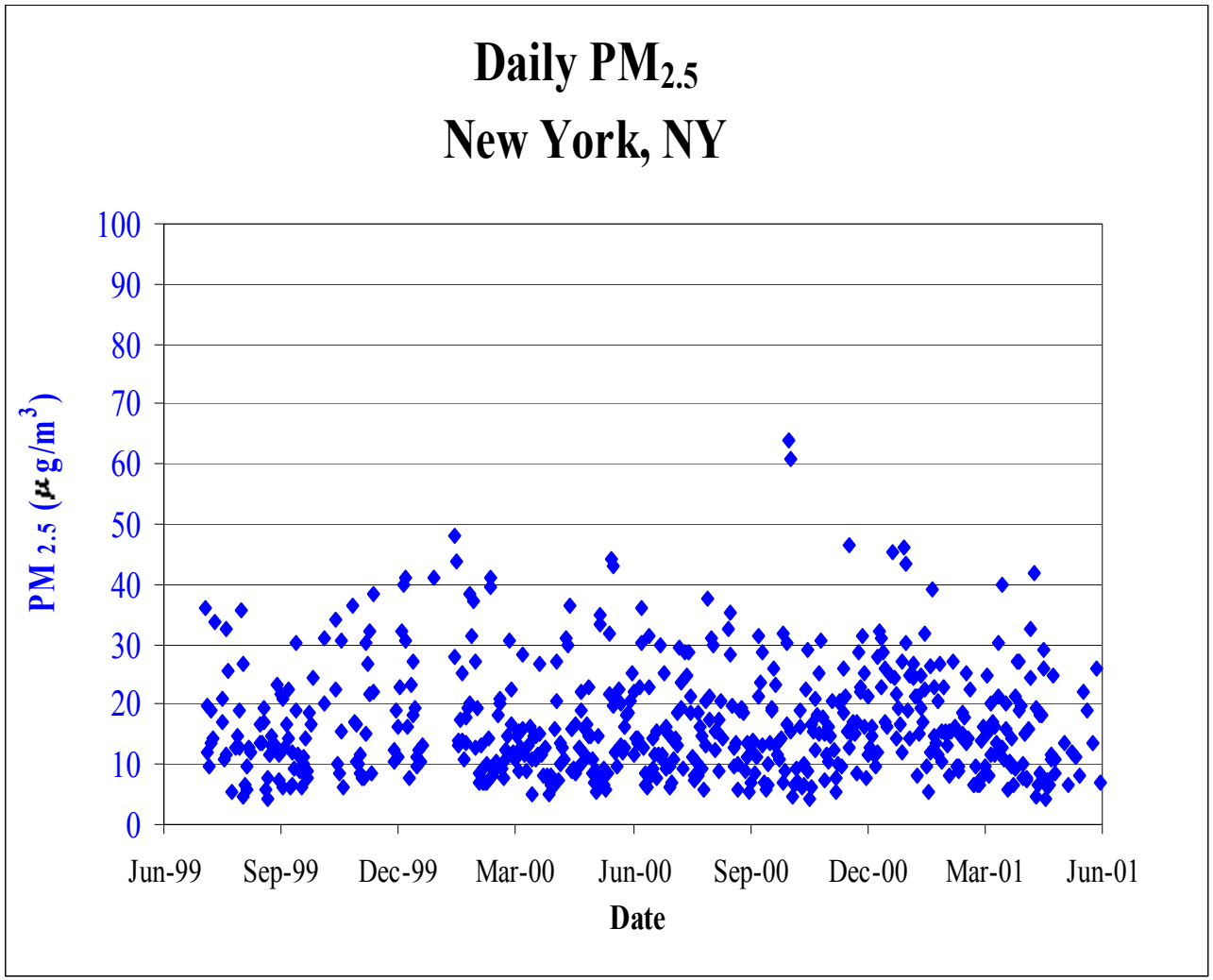
Fig. 4. Daily Air Pollution and Deaths

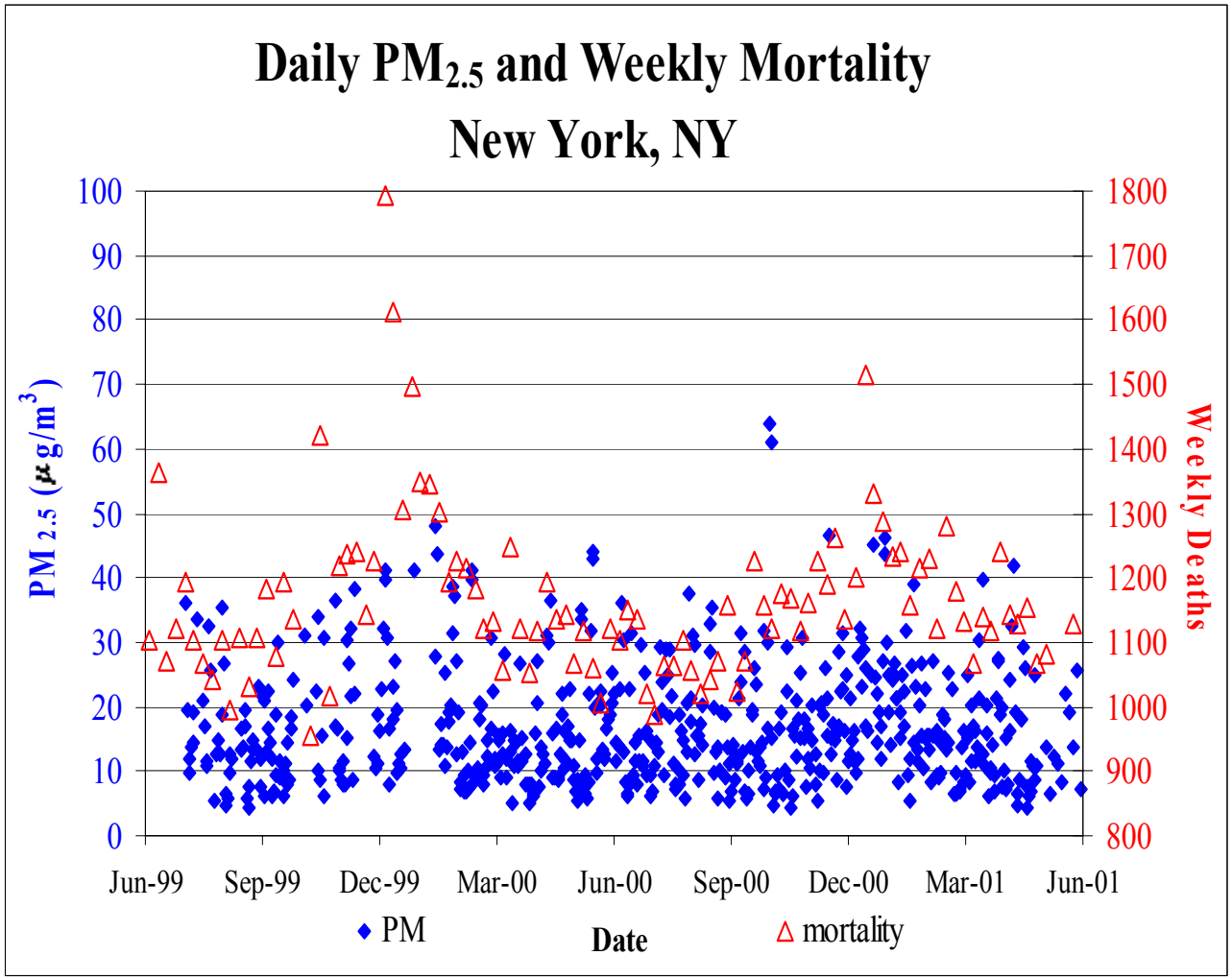
- Correlations between daily mortality and the air quality were very clear.
- "Smoke" and SO_2 *per se* unlikely to have been causal agents.
- Meteorological inversion and fog trapped thousands of pollutants, gaseous and otherwise, from motor vehicles, factories, and some 1,000,000 domestic stoves inefficiently burning poor quality soft coal.
- Air quality there and then is no model for air quality in U.S. today.

0.065 mg/m^3
Daily $PM_{2.5}$ NAAQS

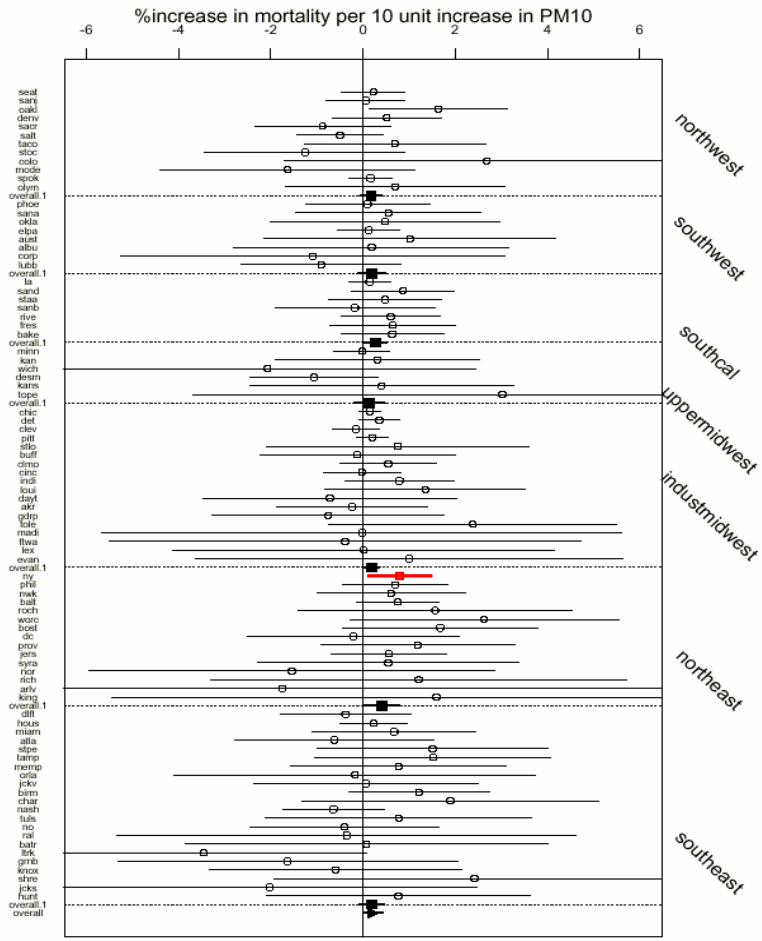
0.015 mg/m^3
Annual $PM_{2.5}$ NAAQS


Weekly Mortality
New York, NY
Weekly Deaths
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
Jun-99
Sep-99
Dec-99
Mar-00
Jun-00
Sep-00
Dec-00
Mar-01
Jun-01
Date


Daily PM2.5
New York, NY
PM 2.5 (µg/m3)
100
90
80
70
60
50
40
30
20
10
0
Jun-99
Sep-99
Dec-99
Mar-00
Jun-00
Sep-00
Dec-00
Mar-01
Jun-01
Date


Daily PM2.5 and Weekly Mortality
New York, NY
PM 2.5 (μg/m3)
Weekly Deaths
100
90
80
70
60
50
40
30
20
10
0
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
Jun-99
Sep-99
Dec-99
Mar-00
Jun-00
Sep-00
Dec-00
Mar-01
Jun-01
PM
Date
mortality

The National Morbidity, Mortality, and Air Pollution Study (NMMAPS)



- NMMAPS is the most extensive recent analysis of daily PM levels and mortality rates.
- The figure shows the "most likely estimate" and 95% confidence interval of the % increase in mortality per 10 μg/m^3 increase in PM_{10} (May 2002 update).
- New York City (in red) is one of only two cities with a statistically positive result.
- Estimates of effect this close to null, combined with problems of residual confounding, preclude causal interpretation.

Epidemiologically, there is nothing special about $PM_{2.5}$

Pollutant	Mean concentration	Increase in all-cause mortality, per conc. change = mean	95% confidence interval
NO_2	24 ppb	2.8%	2.1%-3.5%
PM_{10}	31.3 µg/m^3	2.0%	1.5%-2.4%
$PM_{2.5}$	18.3 µg/m^3	2.0%	1.2%-2.7%
CO	1.1 ppm	1.7%	1.2%-2.2%
O_3	31.2 ppb (daily max)	1.6%	1.1%-2.0%
SO_2	9.4 ppb	0.9%	0.7%-1.2%

Stieb *et al.*, 2002, *J. Air Waste Manag. Assoc. 52*(4):470-84.

Pollutant	Average ambient concentration	Acutely lethal concentrations	
		LC_{lo}	LC_{50}
NO_2	24 ppb	200,000 ppb [human] 65,000 ppb [dog]	1,000,000 ppb [mouse] 315,000 ppb [rabbit] 88,000 ppb [rat] 30,000 ppb [guinea pig]
PM_{10}	31.3 μg/m^3	**not established**	**not established**
$PM_{2.5}$	18.3 μg/m^3	**not established**	**not established**
CO	1.1 ppm	4,000 ppm [human; dog]	5,700 ppm [guinea pig] 2,400 ppm [mouse] 1,800 ppm [rat]
O_3	31.2 ppb (daily max)	50,000 ppb [human]	36,000 ppb [rabbit] 34,500 ppb [cat] 24,800 ppb [guinea pig] 12,600 ppb [mouse] 10,500 ppb [hamster]
SO_2	9.4 ppb	1,000,000 ppb [human; guinea pig]	3,000,000 ppb [mouse] 2,520,000 ppb [rat]

Inhaled sulfate is remarkably nontoxic

1. Most bronchodilator medications used to *treat* asthma (such as albuterol) are supplied as *sulfate salts*.
2. Each puff from inhaler = 20 μg of sulfate.
3. Since a person breathes 0.002 m^3 of air with each puff, this provides 10,000 $\mu g/m^3$ sulfate. This is not known or believed to cause harm.
4. Ambient levels ≈ 5 - 10 $\mu g/m^3$ sulfate.